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ABSTRACT

School change can be greatly impacted by teachers who take an active role in leadership. Teacher leaders should continue to expand their roles and influence in effecting the types of school reform that will lead to sustainable change in the quality of education. Since professional development is key to change, this chapter will address three areas that have not been adequately emphasized in the delivery of professional development programs: diversity, technology, and policy. Teacher leaders must be provided with opportunities to develop skills necessary to provide leadership relevant to these areas. This chapter provides some perspective on the importance of these issues in reforming mathematics and science education and considers the roles of teacher leaders in influencing needed change. (Contains 49 references.) (Author/MVL)

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15 Diversity, Technology, and Policy: Key Considerations in the Development of Teacher Leadership

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School change can be greatly impacted by teachers who take an active role in leadership. Teacher leaders should continue to expand their roles and influence in effecting the types of school reform that will lead to sustainable change in the quality of education. Since professional development is key to change, this chapter will address three areas that have not been adequately emphasized in the delivery of professional development programs: diversity, technology, and policy. Teacher leaders must be provided with opportunities to develop skills necessary to provide leadership relevant to these areas. This chapter provides some perspectives on the importance of these issues in reforming mathematics and science education and considers the roles of teacher leaders in influencing needed change.

The emergence of teacher leaders as integral members of schools' management teams has been a positive outgrowth of site management emphases during the last decade. Preceding chapters in this work have elaborated on the importance of teacher leaders and how professional development opportunities play a key role in fostering skills necessary for these leaders to become effective agents of change. As we look at the roles that teacher leaders will be asked to assume, it is particularly important to consider the types of leadership skills necessary for their work, as well as how those skills might best be enhanced and developed. The intent of this chapter is to explore these important considerations. Specifically, what kinds of skills will teacher leaders in mathematics and science education be required to demonstrate? And, how can we best achieve those ends through inservice and professional development opportunities?

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In order to provide a context for an elaboration of these two questions, this chapter has been centered around three areas that are paramount to the successful reform of mathematics and science education. For teacher leaders in mathematics and science to be effective change agents, they must develop knowledge and skills in areas related to *diversity*, *technology*, and *policy making*.

Diversity

Recognizing Diversity Issues in Mathematics and Science Education

Our classrooms are diverse communities made up of growing numbers of individuals from increasingly varied backgrounds. Yet, unfortunately, positive experiences for many diverse learners in mathematics and science classrooms continue to be few and far between (Carey, Fennema, Carpenter, & Franke, 1995). As history has demonstrated, mathematics and science continue to serve as a filter, if not a gatekeeper, for full participation in our society (National Council of Teachers of Mathematics [NCTM], 1989; Tate, 1994). Sadly, this filtering process has often taken place along lines of gender, race, and socio-economic status (Carey et al., 1995; Ladson-Billings, 1995). Hence, if all learners in our schools are indeed entitled to equal educational and career opportunities, then mathematics and science teaching must undergo significant changes in order to reflect and honor the diverse cultures and contexts inherent in our schools and communities.

One of the daunting challenges in this area is to address the imbalances in the teaching force and our student population. The school age population in the United States continues to reflect an increasing diversity of racial, ethnic, and cultural groups. In many school districts, the majority of students are from minority groups (Banks, 1991). These changing demographics in school populations provide a stark contrast to a modest (at best) increase of teachers of color (Zeichner, 1996), estimated to be no more than 15% of the teaching force by the year 2000 (Banks, 1991). Hence, teachers will continue to be white, mostly monolingual, and will have backgrounds and experiences that vary considerably from many, if not most, of their students (Zeichner, 1996).

Moreover, it has also been shown that minority students and those at-risk are disproportionately taught by teachers who are less experienced and less qualified (Stover, 1999). Estimates from the

National Center for Education Statistics (cited in Stover, 1999) indicate that disadvantaged high school students are 50% to 100% more likely to be taught by a teacher without proper training in the subject. This situation is further compounded by the current crunch in demand for mathematics and science teachers. Estimates indicate that as many as 28% of grades 7-12 mathematics teachers, and 18% of science teachers, are teaching without academic major or minor degrees in those respective fields (Ingersoll, 1999).

Defining Roles for Teacher Leaders.

Given these troubling statistics, it would appear that a new generation of teacher leaders must embrace these issues of equity and diversity inherent in our mathematics and science classrooms, and take active leadership roles in making mathematics and science instruction relevant, engaging, and meaningful for all learners. Potential roles that teacher leaders should assume would first and foremost include the development of exemplary practices and "culturally relevant pedagogy" (Ladson-Billings, 1994) within their own classrooms. Malloy and Malloy (1998) stress the importance of having knowledge of classroom culture that promotes learning. This includes an understanding of the importance of multicultural education, the integration of multicultural materials and pedagogy into teaching, and an awareness of learning preferences so pedagogy can be adjusted to capitalize on those preferences. As other chapters in this volume have illustrated repeatedly, the modeling of best practice in mathematics and science instruction that teacher leaders can provide holds great promise for impacting change in school classrooms.

In addition to modeling teaching practices that honor and reflect the diversity of our classrooms, it would seem imperative that teacher leaders actively support and mentor new teachers so that they not only develop sound pedagogical practices, but also remain committed to teaching as a career calling. Given the already low percentages of teachers of color in the workforce, it is important for teacher leaders to take active roles in developing support structures and nurturing environments for teachers of color in the early stages of their careers. This is particularly important given that minority teachers can serve as the necessary change agents in schools and society through their clear and strong vision for social justice and their own perceptions of their roles in this change process (Su, 1998).

In short, teacher leaders can become actively involved in raising an awareness of the need for minority teachers by raising issues, developing and enacting policy decisions, and providing support to increase the numbers of minority teachers. Through teacher leaders, programs can be developed in schools to encourage and support minority students who have the potential to become teachers. Teacher leaders could extend programs such as Future Teachers of America, Teacher Cadets, Grow a Teacher, and Future Educators of America to give minority students opportunities to work with teachers in developing their interest in mathematics and science education. Mentoring programs that foster relationships between master teachers and minority teacher candidates provide a positive induction experience into the classroom (Futrell, 1999). Ultimately, minority teachers must be encouraged and mentored to become teacher leaders in the school and larger educational community.

Models For Professional Development

It is essential that our teachers have the knowledge, skills, and training necessary to reach diverse students (Futrell, 1999). Yet, even as fewer teachers from diverse backgrounds are being trained, teacher candidates report that their teacher education programs have inadequately prepared them to teach students from backgrounds dissimilar from their own (Ashton, 1996). As Cochran-Smith (1995) has suggested, there continues to be mounting evidence that "teachers are most able to understand, set appropriate expectations, and provide strategic support for students who are like themselves in culture, race, and ethnicity" (p. 542). Gomez (1996) has extended this notion to suggest that, not only are teachers apt to better support students who are similar in cultural background, they often view students who are unlike themselves "as children who are not only different, but deficient learners who are undesirable to teach" (p. 109).

In order to respond to these conceptions that teachers bring to their work, professional development must challenge teachers to confront these issues and to develop skills necessary in promoting equitable, multicultural mathematics and science education. Teacher leaders in particular must be central in this pursuit as they provide support for schools in implementing effective pedagogies to reach all students. Several models of this kind of professional development provide insight and examples for future work with teachers, and for the professional development of teacher leaders in particular.

Collaborative Redesign of Educational Systems in Texas (CREST) utilized a professional development school model under the guidance of mentor teachers and university faculty to continuously improve and assure equity and excellence among all learners (Patrick & Reinhartz, 1999). The program included tasks that examined issues of effective instructional strategies, principles of classroom management, and assessment as they apply to diverse settings. Participants also analyzed textbooks and materials for representation of people and issues from diverse populations, wrote and implemented lessons.

Mathematics Education, Equity, and Leadership (MEEL) is a professional development program committed to reforming mathematics education, promoting equity, and developing teacher leadership (Peterson & Barnes, 1996). The program has as its central mission the development of teacher leaders who are committed to equity in mathematics education. The program stresses fostering safe environments for learning so that teachers can be challenged to wrestle with important mathematics while also working toward relating mathematics to students' lives. The importance of creating such a mathematical community is instrumental in assisting teachers to consider constructivist teaching and change their practice (Pugalee & Malloy, 1999). In MEEL, conversations and discussions help teachers deal with deeply-held beliefs. The goal is to help teachers become aware of equitable mathematics reform as representative of personal as well as social change. Leadership is fostered through the development of confidence. Participants are given supported experiences in leading during the sessions. Through these opportunities, teachers are provided with active experiences to mold their confidence and to help each define what he or she needs to lead effectively. Through the interaction of these three objectives (reforming mathematics education, promoting equity, and developing teacher leadership) participants come to understand that learning is risky and leaders need to help create safe communities and contexts for learning and sharing.

In addition to programs focusing on the development of leadership, teacher leaders must become aware of effective programs that address the needs of minority students. Knowledge of such programs provides a framework for teacher leaders to identify the characteristics of successful programs as they plan and advocate for change in their own schools and communities. One example of such a program is the Science/Technology/Society (STS) approach that has a research

and practice base spanning twenty years (Weld, 1999). The program emphasizes current issues in society and the lives of students as the foundation for study. Students are involved in planning the activities and become actively engaged in researching the issues and finding possible ways to resolve them. Students in this program demonstrate better attitudes toward science, improve their ability to apply science to daily problems, exhibit more equitable achievement outcomes in science across gender and ethnic lines, increase their decision making capacity, illustrate greater creativity, and perform on standardized tests as well as or better than students in traditional approaches. It is promising programs such as these that provide teacher leaders with information relative to educating diverse populations.

Summary: Equity, Diversity, And Teacher Leaders

The preceding paragraphs explored the roles and potential development of teacher leaders in fostering more equitable and relevant teaching in mathematics and science. Central to these roles and goals are the development of opportunities for teachers to address controversial issues on a personal and intellectual level so that they develop a better understanding of how these issues impact the culture of the school and community (Wiggins & Follo, 1999; Weissglass, 1994). Ladson-Billings (1994) asserts that successful teachers of diverse students need to develop knowledge of the community and the norms of the culture. Hollins (1995) notes that congruency between school culture and home culture facilitates communication, whereas differences interfere with communication and subsequently with learning. Particular to the study of mathematics, Tate (1994) has built upon this notion to suggest the importance of connecting the pedagogy of mathematics to the lives and daily experiences of diverse students. Toward that end, Ladson-Billings (1994) has identified three critical components of culturally relevant teaching: the teachers' conceptions of themselves and others; the manner in which classroom social interactions are structured; and teachers' conception of knowledge. Building on the successes of other programs that have been effective in addressing these components as articulated by Ladson-Billings should be the goal of those interested in helping teachers develop leadership ability in promoting equitable learning opportunities for children in mathematics and science classrooms.

Technology

Technology and Mathematics and Science Education

A second primary area around which professional development for teacher leaders should be focused is the area of educational technology. In the fields of mathematics and science, technology is viewed as an important tool, which supports the development of inquiry and assists in the solving of problems (NCTM, 1989; National Research Council, 1996). Classroom applications of technology (software programs, hand-held graphing calculators, Calculator Based Laboratories (CBL's), probe ware, and other tools) have significantly impacted not only *what* mathematics and science content is now emphasized in school curricula, but *how* that curricula is experienced by students.

In the past several years, technology has been poured into mathematics and science classrooms. The ratio of students per multimedia computer has decreased from 21 in 1996-97 to 14 in 1997-98. The number of classrooms connected to the internet reached 51 percent in 1998 (U. S. Department of Education, 1999). Hand-held graphing calculators have also been widely implemented and are now commonplace in high school classrooms. Likewise, CBL systems have similarly impacted mathematics and science instruction as this technology has allowed students to actively and individually experience various phenomena through authentic, inductive exploration. This integration of technology has demonstrated positive effects on student performance (Funkhouser, 1993; Wenglinsky, 1998), making it all the more important that teacher leaders develop the skills to guide and shape technology use in school mathematics and science classrooms.

Defining Roles for Teacher Leaders

As our society and schools become more technologically oriented, it is vital that teachers have the skills and knowledge to use these tools effectively and that teacher leaders assist in the development and implementation of technology plans for their schools and school systems. Teachers should have a voice in the technology plans that will ultimately impact curricular and instructional programs. School systems must have coordinated plans to provide the infrastructure, the hardware, the software, and the training resources necessary to effectively implement developed technology plans. Teacher leaders must be at the forefront of this endeavor to provide information and

guidance, particularly related to the types of technology applications which best meet the needs of teachers and students (United States Congress Office of Technology Assessment, 1995).

Teacher leaders must also be able to provide expertise and guidance in the instructional *use* of technology. As suggested earlier, technology can support inquiry-based learning where students engage in active investigation of challenging content. Such explorations provide students with opportunities to understand difficult concepts earlier and more readily through interactive visualization, simulation, and hands-on modeling (United States Department of Education, 1999). All of this potential for student learning can be tapped if teacher leaders are prepared not only to model effective use of technology in their instruction, but also to work closely with colleagues in the development of school wide, cohesive use of technology.

Such leadership is vital given the current status of professional development in technology education. For example, a 1998 survey showed that only 20 percent of classroom teachers felt prepared to integrate educational technology into their instruction (United States Department of Education, 1999). Teachers report having low skills in designing lessons and classroom applications which utilize technology (Pugalee & Robinson, 1998; Willis & Mehlinger, 1996; United States Congress Office of Technology Assessment, 1995). Findings such as these confirm common sentiments shared informally and anecdotally in schools across our nation: while teachers recognize the wonderful promise of technology for the learning of their students, they feel overwhelmed by the task of developing the skills and aptitude to use it effectively in the classroom. The promise of effective inservice models, however, is evident. Instructional programs which provide teachers with training and opportunities to design and reflect on the instructional design process can have a significant positive impact on teachers' reported skills level (Pugalee & Robinson, 1998).

In order for teachers to use technology effectively, they must change the way they teach. Teachers who use technology change their teaching so that it is less teacher directed while providing students with a greater degree of autonomy (Nicaise & Barnes, 1996; Owston, 1997; Rogan, 1995; Topp, Grandgenett, & Mortenson, 1995). Many teachers also believe that the use of technology is controversial, stressing fears of students' over dependence on calculators (Milou, 1999). Simmt (1997) reported that teachers primarily used graphing calculators for verification of work and minimally in problem

exploration. Perhaps the most challenging role facing teacher leaders, therefore, is to work toward the creation of effective professional development opportunities for teachers. Teacher leaders must find ways to provide ongoing support structures that not only provide for the development of technological skills and knowledge necessary for teachers to effectively plan instruction with technology integration, but also to assist teachers in changing their teaching philosophies, attitudes, and beliefs about the use of technology.

Professional Development for Technology Education

In order to effectively participate in such roles, teacher leaders must acquire technological expertise as well as the leadership skills necessary to promote and sustain instructional changes in their schools. Table 1 identifies the role of professional development in providing training about technology and with technology. Professional development must play a key part in providing teachers with basic information to be leaders in advocating effective technology plans and practices.

Technology itself has tremendous potential as a tool for professional development. Several professional development programs in mathematics and science demonstrate promise in providing the types of experiences teacher leaders need in order to impact classroom instruction and, ultimately, the learning of students. Two technology oriented systems, MathLine and Education Future Center (EFC), are highlighted in the following paragraphs.

MathLine provides participants with multimedia experiences designed to assist them in implementing reform based teaching practices into their classroom. The program is developed by the Public Broadcasting Corporation (http://www.pbs.org/mathline/). There are programs designed for elementary, middle, and secondary teachers. Professional quality video segments of classroom teachers provide participants with cases of actual classroom experiences. These cases present teachers with models of effective pedagogy and encourage reflection related to significant reform ideas. On-line discussion forums provide participants with opportunities to extend their professional community outside their physical school setting. The discussions offer a forum for teachers to discuss implementation of reform based teaching practices. Lesson resources provide substantive detail including information on important concepts and the types of inquiry based questions that will promote student learning.

Table 1. The Role of Technology in Professional Development Projects

Training About Technology

- Acquainting teachers with the use of a specific technology
- Familiarizing teachers with a variety of technology tools and applications
- Training teachers to use technology to facilitate new instructional approaches
- Teaching teachers to integrate technology into a specific subject
- Helping teachers learn to incorporate technology across the curriculum

Training With Technology

- Delivering telecourses or teleconferences by satellite
- Videotaping training sessions
- Videotaping and critiquing of teacher performance
- Modeling good instruction on video
- Using Computer-assisted training modules for independent study
- Using laboratory tools for research assignments or internships
- Using telecommunications networks for research, interaction, and collegial work
- Providing computer databases on instructional issues
- Providing computer or video guides to accompany training materials

Adapted from United States Congress, Office of Technology Assessment, 1995, p. 235.

The Education Future Center is a consortium of partners in education, government, business, and foundations spearheaded by the North Carolina School of Science and Math. The consortium has seven Cyber Campuses spread throughout the state. These Cyber Campuses are technology rich environments which provide opportunities for interaction and collaboration on regional, national and international levels. Discussion groups of staff and partners provide a means of sharing information and discussing and offering solutions to problems. Teacher workshops are currently being offered

under the Education Future NOW program. Three benchmarks guide the current program: core technology skills, integrating technology into the classroom, and job-embedded learning (http://www.efc.ncssm.edu/).

The core technology skills benchmark includes basic applications of technology as well as development of knowledge in the ethical use of technology and the development of skills necessary to access, analyze, and communicate information for problem solving. The second benchmark is concerned with themes and newer concepts related to specific content and grade levels, the ability to use technology to access data, visualize concepts, and engage students in inquiry. These workshops are designed to promote peer collaboration and reflective practice. The third benchmark encourages the development of independent professional development plans, classroom research, pairing with peers for lesson development and assessment, formation of study groups, and capacity building through professional writing, conference presentations, and development of multimedia projects.

There also appears to be some promise in providing professional development opportunities for teacher leaders through participation with university teacher preparation programs. In a recent study, Frykholm and Meyer (in press) explored the impact of an innovative college course that had as its students a mixture of preservice teachers, graduate students (who served as student teacher supervisors), and practicing classroom teachers (who also served as cooperating teachers for the internship experience of the preparation program). The course focused on innovative and recent technological applications for the classroom, while at the same time building on the collaborative relationships that were emerging among the constituents in the course. Powerful collaborations emerged which were found to positively impact not only the knowledge and skills of the teachers, but also their work together in the school setting.

Summary: Technology and Teacher Leadership

This discussion on technology has underscored the importance hich technology plays in the improvement of mathematics and science learning. Also evident was the significant role which teacher leaders must play in effecting the types of changes that will result in the effective use of educational technologies. The discussion substantiates the importance of teacher leaders in fulfilling the strategic recommendations of the President's Committee of Advisors on Science

and Technology (1997): focus on learning with technology, not about technology; emphasize content and pedagogy, and not just hardware; give special attention to professional development; engage in realistic budgeting; ensure equitable, universal access; and initiate a major program of experimental research. Technology is a learning tool that will continue to dramatically alter the study of mathematics and science. In order to capitalize on the potential of this tool, teachers must become actively involved in providing the types of technology leadership which will allow our schools to adequately prepare students today and in the future.

Policy

Policy and Teacher Leadership

Over the last decade, there have been important increases in the opportunities for teachers to become involved in leadership. This new sense of ownership has advanced the professionalization of teaching and improved both teacher and student learning. These multiple opportunities have thrust teachers into experiences as mentors of new teachers, coaches to other leaders, peer evaluators, members of team-teaching groups, specialists to assist colleagues with competency issues, curricula writers, designers of professional development, writers and speakers about teaching and learning, researchers, and models of more accomplished teaching practices (Urbanski & Nickolau, 1997).

These new roles require new ways of thinking about teachers and teacher leaders in particular. In order for these new ways of thinking to change the culture of schools and school leadership, policy must also come to reflect the values of teacher leadership. Urbanski and Nickolau (1997) have drawn attention to implications of these developments by identifying some areas to consider if teacher leadership is to become established as an integral component of effective schools:

- teachers must be provided with opportunities to engage in policy making.
- new roles for teacher leadership must be extended and supported.
- support must include more time and increased access to new knowledge and skills (pp. 249-250).

Roles and Opportunities for Teacher Leaders in Policy Making

There is a growing body of research that suggests that teacher leaders must be more closely linked to the processes whereby policy decisions are made. Sherrill (1999) refers to this fundamental challenge in fostering teacher leadership by noting research that demonstrates that teachers have been unresponsive to top-down initiatives calling for the improvement of teaching. Research indicates that teachers are more likely to impact their practice as a result of collaborative interactions with colleagues (Mitchell, 1997; Wasley, 1991; Rosenholz, 1989). Such collaborative environments are crucial in the development of positive school climate (Whitaker, 1995; Firestone, 1993) and important in allowing the exchange and debate of ideas, which leads to professional autonomy (Castle & Aichele, 1994). Hence, facilitating processes whereby teachers assume leadership roles has become increasingly important.

One specific role of teacher leaders is to work toward creating the mechanisms whereby teachers' collective voices may be heard. In order to facilitate this process, teacher leaders should help colleagues form groups and unify their voices such that they may participate in the decisions that shape the work and mission of their schools. Presently, teachers largely work in isolation. To overcome this current level of isolation, schools must involve teachers at a higher level in collaborative experiences, professional development, and leadership. The involvement of groups of teachers who have the support of the school and district administration, students, parents, and the broader school community was identified by Clarke (1994) as one of the ten important principles of professional development. Involvement of such a grand scale will require policy decisions that provide mechanisms to support teachers with materials, resources and time.

As suggested earlier, teacher leadership roles must also be developed to allow for exemplary practicing teachers to assist other teachers, particularly inexperienced ones (Hyde, Ormiston, & Hyde, 1994). This is especially important in identifying subject area specialists, particularly in mathematics and science, who can provide ongoing support and information to teachers, and help them adapt to the major changes in curriculum, scheduling, and assessment demanded by reform methodologies (Windschitl, 1999). In this vital time of reform in mathematics and science education, the need for teacher leaders in the effective identification, implementation, and

evaluation of such practices is essential. In addition, the roles of teacher leaders should be extended to allow for the impact of these leaders in influencing policies and practices within their districts as well as the state and nation.

Models and Directions for Professional Development

Teachers' responsibilities make it difficult for them to access the kinds of information and acquire the types of skills necessary to develop leadership. Opportunities must be provided, therefore, for teachers to have access to such resources. Some successful approaches reported by Firestone (1993) include large-scale staff development modeling active learning such as Gheens Academy in Louisville and Schenley High in Pittsburgh, the use of professional development schools combining inservice for current teachers with preservice preparation, and the use of teacher networks such as the Ford Foundation's Urban Mathematics Collaboratives, Coalition for Essential Schools, and California's Math A Network.

The professional growth of teachers is greatly limited by a lack of time for professional reading and reflection, a lack of joint planning time with other teachers, and a lack of opportunities to work together in classrooms (Clarke, 1994). Teacher leaders' lack of time with students and colleagues was identified as a major barrier to professional growth (LeBlanc & Shelton, 1997). These barriers greatly constrict the abilities of teacher leaders to positively effect change in instruction. Policy makers must therefore begin to change organizational structures of schooling that contribute to professional isolation if teachers and teacher leaders are to have time and accessibility to peruse and reflect on the knowledge necessary to gain new skills.

Teacher leaders must have opportunities to develop new skills that are necessary to extend their roles in the classroom to include work with adult peers (Sherrill, 1999). These skills include the ability to develop relationships and nurture the growth and development of other teachers. Specific to this task would be development of skills that would lead to observations of classroom instruction, and mentoring of teachers as well as consulting on issues related to classroom management, lesson development, and effective instructional practices. Table 2 identifies some of these core expectations for teacher leaders (Sherrill, 1999).

Table 2. Core Expectations for Teacher Leaders

- Demonstrate exemplary classroom instruction and sound knowledge of effective teaching and learning strategies.
- Understand theories of adult development.
- Demonstrate knowledge of clinical supervision models and processes that support effective descriptions of classroom practices.
- Cultivate desired dispositions in teachers.
- Guide colleagues by a reflective and inquiry-oriented posture.
- Possess research-based knowledge about teaching and learning.

Based on Sherrill, 1999, p. 60.

Summary of Teacher Leadership and Policy

Designers of professional development for teacher leaders have not paid adequate attention to the development of skills that are necessary for influencing and making policy decisions. The National Board for Professional Teaching Standards recognizes the essential nature of such skills in one of the five propositions in their standards for national certification. Proposition five states that "Teachers are members of learning communities." Elaboration of this proposition characterizes the effective teacher as one who works collaboratively with other professionals on instructional policy, curriculum development, and staff development. Further, they can evaluate school programs and the allocation of school resources (Darling-Hammond, Wise, & Kline, 1995). Such expectations do not support passive roles for teachers who only exert influence within the realm of their individual classrooms. Teachers must be leaders who work to influence the policy directions which impact their schools and their profession. The scarcity of professional development programs that target the development of such skills is alarming. If teacher leaders are to *lead*, professional development must begin to address how to best prepare the participants to assume roles within their schools, districts, and larger educational communities that will guide the decision making machinery which ultimately impacts individual student learning.

Conclusions

As professional development opportunities designed for teacher leaders strengthen components in the above considerations, our teachers will be better prepared to deal with these issues within the complex educational community. In this paper, we have attempted to highlight some of the roles that teacher leaders might assume, as well as mechanisms to provide development opportunities for teachers to be willing and able to embrace these new roles. In so doing, we also pointed toward three key issues that will fundamentally shape the direction and success of reforms in mathematics and science education. Specifically, issues of diversity will become more vital as our schools become more diverse. We must respond to these changes so that mathematics and science no longer act as the gatekeepers for large portions of our student population. Technology will continue to be a major factor in the future education of young mathematicians and scientists. Our teachers must lead this call not only by using technology in the classroom to enhance the learning experiences of students, but also to prepare them for successful entry into an ever-more technologically oriented society. Finally, the political landscape will require ever-increasing expertise on research and related issues in order for our teacher leaders to provide the necessary leadership to guide changes in curriculum and instruction. The consideration of these factors is key to strengthening the capabilities of our teachers to develop as leaders of the profession.

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